



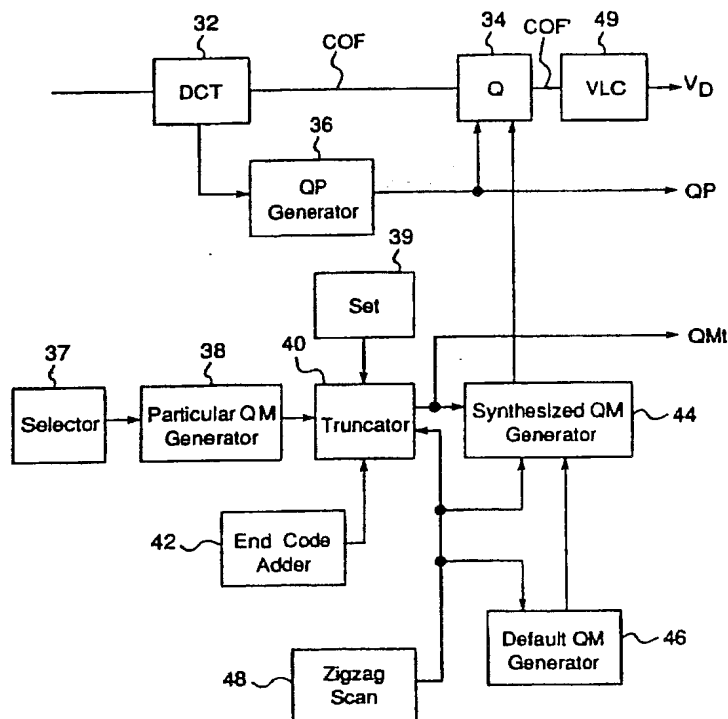
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: QUANTIZATION MATRIX FOR STILL AND MOVING PICTURE CODING

## (57) Abstract

An encoder and a decoder for still and moving picture are disclosed. The encoder has a memory for storing a default quantization matrix including a plurality of quantization elements having predetermined values. Also, a generator is provided for producing a particular quantization matrix after a number of frames. The particular quantization matrix is read in a predetermined zigzag pattern, and the reading is terminated at a selected position which is in the middle of the zigzag pattern. An end code is added after the read quantization elements of a former portion of the particular quantization matrix. The quantization elements in the default quantization matrix are read in the same zigzag pattern from a position immediately after the selected position, and producing a latter portion of the default quantization matrix. The former portion of the particular quantization matrix and the latter portion of the default quantization matrix are synthesized to form a synthesized quantization matrix.



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## DESCRIPTION

## Quantization Matrix for Still and Moving Picture Coding

## Technical Field

5           This invention is particularly useful in the coding of still and moving pictures at very high compression. It is suitable for use in video conferencing applications over standard telephone lines as well as for other applications that require high compression.

## Background Art

10           In most compression algorithms some form of loss in the decoded picture is expected. A typical method for compression that produces good results is to introduce this loss by quantizing the signal in the transform domain instead of the pixel domain. Examples of such transforms are the Discrete Cosine Transform, DCT, the wavelet transforms and the subband analysis  
15 filters. In a transform based compression algorithm, the picture is converted into the transform domain and a quantization scheme is applied to the coefficients to reduce the amount of information. The transformation has the effect of concentrating the energy into a few coefficients and noise can be introduced into these coefficients without affecting the perceived visual quality  
20 of the reconstructed picture.

          It is well known that some form of human visual perception system with different weighting on the quantization on different coefficients can improve the perceived visual quality. In coding standards such as the ISO/IEC JTC1/SC29/WG11 IS-13818-2(MPEG2), the quantization of the DCT  
25 coefficients are weighted by the quantization matrix. A default matrix is normally used however the encoder can choose to send new values of the

quantization matrix to the decoder. This is done through the signaling in the bitstream header.

The prior art on sending Quantization Matrix based on the MPEG-2 video standard, is to send 64 fixed values of 8-bit each if the bit signaling for using a special Quantization Matrix is set to "1".

The values of the matrix in the position of higher frequency band are actually not used, especially for very low bit rate coding where a large quantization step is employed, or for an input block with very plain texture or with good motion compensation.

It is also found that, in the above prior art, for any of Quantization Matrix used in different applications, the first value of quantization matrix is always set to eight, no matter whether it is low bit rate coding or high bit rate coding.

One problem with this method is the amount of information that need to be sent as part of the quantization matrix. In a typical case all 64 coefficients each of 8 bits are required. This represents a total of 512 bits. If three different Quantization Matrices are required for three bands of colour information, then the total bits will be three times of that amount. This represents too much overhead for low bit rate transmissions. It results in too long a set up time or latency in the transmissions should the matrix be changed in the middle of the transmission.

The second problem to be solved is the spatial masking of the human visual system. Noise in flat regions are more visible than noise in textured regions. Therefore applying the same matrix to all regions is not a good solution as the matrix is globally optimized but not locally adjusted to the activity of the local regions.

The third problem to be solved is the bit saving from the variable

quantization matrix value for DC. The first value in Quantization matrix is decreased for higher bit rate and flat region and increased for lower bit rate and textured region.

#### Disclosure of Invention

5           To solve the above problem to reduce the transmission data, an encoding method for encoding a quantization matrix for still and moving picture, according to the present invention, comprises:

          holding a default quantization matrix including a plurality of quantization elements having predetermined values;

10           generating a particular quantization matrix including a plurality of quantization elements having selected values;

          reading said particular quantization matrix in a predetermined zigzag pattern;

          terminating the reading of the particular quantization matrix at a  
15   selected position while reading in the predetermined zigzag pattern, and producing a former portion of the particular quantization matrix;

          adding an end code after the quantization elements of said former portion of the particular quantization matrix;

          reading said default quantization matrix in said predetermined zigzag  
20   pattern from a position immediately after said selected position, and producing a latter portion of the default quantization matrix; and

          synthesizing said former portion of the particular quantization matrix and said latter portion of the default quantization matrix to form a synthesized quantization matrix.

25           According to the present invention, a decoding method for decoding a quantization matrix for still and moving picture comprises:

holding a default quantization matrix including a plurality of quantization elements having predetermined values;

receiving a number of quantization elements and an end code;

5 positioning said received quantization elements in a predetermined zigzag pattern to form a former portion, and terminating the positioning of the received quantization elements upon detection of said end code;

reading said default quantization matrix in said predetermined zigzag pattern from a position immediately after said former portion, and forming a latter portion with quantization elements from the default quantization matrix;

10 and

synthesizing said former portion of the particular quantization matrix and said latter portion of the default quantization matrix to form a synthesized quantization matrix.

According to the present invention an encoder for encoding a  
15 quantization matrix for still and moving picture comprises:

a holding member which holds a default quantization matrix including a plurality of quantization elements having predetermined values;

a generating member which generates a particular quantization matrix including a plurality of quantization elements having selected values;

20 a reading member which reads said particular quantization matrix in a predetermined zigzag pattern;

a terminating member which terminates the reading of the particular quantization matrix at a selected position while reading in the predetermined zigzag pattern, and producing a former portion of the particular quantization  
25 matrix;

an adding member which adds an end code after the quantization elements of said former portion of the particular quantization matrix;

a reading member which reads said default quantization matrix in said predetermined zigzag pattern from a position immediately after said selected position, and producing a latter portion of the default quantization matrix; and

a synthesizing member which synthesizes said former portion of the particular quantization matrix and said latter portion of the default quantization matrix to form a synthesized quantization matrix.

According to the present invention, a decoder for decoding a quantization matrix for still and moving picture comprises:

a holding member which holds a default quantization matrix including a plurality of quantization elements having predetermined values;

a receiving member which receives a number of quantization elements and an end code;

a positioning member which positions said received quantization elements in a predetermined zigzag pattern to form a former portion, and terminating the positioning of the received quantization elements upon detection of said end code;

a reading member which reads said default quantization matrix in said predetermined zigzag pattern from a position immediately after said former portion, and forming a latter portion with quantization elements from the default quantization matrix; and

a synthesizing member which synthesizes said former portion of the particular quantization matrix and said latter portion of the default quantization matrix to form a synthesized quantization matrix.

A further problems are solved by the following means.

A default matrix is designed to allow a variable number of weights to be updated by the encoder. This method of adjusting the matrix to the picture content at different degrees is hereafter referred to as truncated quantization

matrix.

This truncated quantization matrix can be decided by checking coding bit rate, complexity of coded picture, as well as other aspects. It always requires a small number of non-zero values which are normally concentrated on the DC and the first few AC coefficients, especially in low bit rate coding. Furthermore these non-zero values can be coded differentially, and less than 8-bit for each value will be used to code the difference values.

The quantization weights are scaled according to the activity of the block.

The quantization weights are scaled according to the quantization step size of the block.

The present invention provides a method to increase the efficiency of using quantization matrix from both bit saving and adaptation to individual blocks.

Quantization matrix is decided based on different coding bit rate, as well as other aspects in this way: only the first few values in quantization matrix are set to non-zero with certain weighting, and others are truncated to zero, which are not coded and transmitted.

This truncated quantization matrix is scanned by zig-zag or other ways, differentially coded and transmitted, together with the number of the non-zero values, or terminated by specific symbol.

The weighting scale can be adjusted by checking the number of coefficients left after quantization, since the number of coefficients left can reflect the activity of the block. If only DC coefficient is left after quantization, then the weighting scale for DC should be smaller or equal to 8 because it is flat region, otherwise if a lot of AC coefficients are left, the weighting scale for DC can be larger, for example two times of quantization step. The same adjustment



can be done for the weighting scale for AC coefficients.

#### Brief Description of Drawings

Fig. 1A shows a diagram of an example of a default quantization matrix.

5 Fig. 1B shows a diagram of an example of a particular quantization matrix.

Fig. 2A shows a truncated quantization matrix according to the present invention.

10 Fig. 2B shows a diagram of another example of a particular quantization matrix.

Fig. 3 shows a diagram of an example of synthesized quantization matrix according to the present invention.

Fig. 4 is a block diagram of an encoder according to the present invention.

15 Fig. 5 is a block diagram of a decoder according to the present invention.

Fig. 6 is a block diagram showing one of the ways for encoding the truncated quantization matrix.

20 Fig. 7 shows a diagram of an example of a scaling truncated quantization matrix, which is to scale the value for DC only.

Fig. 8 is a flow chart showing the scaling procedure for DC coefficient in a truncated quantization matrix.

Fig. 9 is a block diagram of a decoder for decoding the scaled truncated quantization matrix.

#### 25 Best Mode for Carrying Out the Invention

The current embodiment is divided into two parts. The first part of the embodiment describes the truncated quantization matrix. The second part

of the embodiment describes the operation of the adaptive quantization step size scaling. Even though the embodiment describes the operations a one unit, both methods can be applied independently to achieve the desired outcome.

Fig. 1A shows an example of a default quantization matrix for intra  
5 Luminance (Intra-Y) frame coding, and Fig. 1B shows an example of particular quantization matrix that quantizes the high frequency coefficients more coarsely.

Fig. 2A is an example of the truncated quantization matrix proposed by the present invention. The key to this embodiment is that the number of  
10 values in the quantization matrix to be transmitted may be less than 64. This is particularly useful especially for very low bit rate coding, where only the first 2 or 3 values are required.

Fig. 4 shows an encoder, according to the present invention, using the quantization matrix for the still and moving pictures. The encoder includes a  
15 DCT converter 32, a quantizer 34, and a variable length coding unit 49. A QP generator 36 for generating quantization parameters after, e.g., every macro-block is provided. The quantization parameter can be calculated using predetermined equation after every macro-block, or can be selected from a look up table. The quantization parameters as obtained are applied to the quantizer  
20 34 and also to a decoder which will be described in detail later in connection with Fig. 5.

In Fig. 4, the encoder further has a particular QM generator 38 for generating particular quantization elements aligned in a matrix format. The particular quantization elements in matrix are generated after every video  
25 object layer (VOL) consisting of a plurality of layers. Examples of the particular quantization elements in matrix QM are shown in Fig. 1B and Fig. 2B. In the case where the video data is sent with less data amount (such as

when the bit rate is low, or when the image is simple), the particular quantization elements shown in Fig. 1B is used in which large amount of quantization elements, such as 200, are used in the high frequency region. The particular quantization elements can be obtained by calculation or by using a suitable look up table. A selector 37 is provided for selecting parameters used in the calculation, or a suitable quantization elements in matrix from the look up table. The selector 37 can be operated manually by the user or automatically based on the type of the image (real picture or graphic picture) or the quality of the image.

10           The particular quantization elements in matrix QM are applied to a truncator 40. The truncator 40 reads the particular quantization elements in matrix QM in a zigzag format, as controlled by a zigzag scan 48, from a DC component to higher frequency components, as shown by dotted lines in Fig 2A. When the truncator 40 reads a preset number of particular quantization  
15 elements in matrix, a further zigzag reading from the matrix QM of block 38 is terminated. Thereafter, an end code, such as a zero, is added by an end code adder to the end of the preset number of particular quantization elements. The preset number is determined by a setting unit 39 operated manually by a user or automatically relatively to the type or quality of the picture. According to an  
20 example shown in Fig. 2A, the preset number is thirteen. Thus, there will be thirteen particular quantization elements being read out before the termination of the zigzag reading. These read out quantization elements are referred to as quantization elements in the former portion, since they are in the former  
portion of the zigzag reading of the particular quantization elements in matrix  
25 QM. The quantization elements in the former portion are sent to a synthesized QM generator 44, and the same quantization elements plus the end code are sent to a decoder shown in Fig. 5. A series of these quantization elements in

the former portion followed by the end code is called a simplified data QMt.

A default QM generator 46 is provided for storing default quantization elements aligned in matrix, such as shown in Fig. 1A. These default quantization elements are also read out in the zigzag form by the  
5 control of zigzag scan 48.

A synthesized QM generator 44 is provided for generating synthesized quantization elements in a matrix form. In the synthesized QM generator 44, the particular quantization elements in the former portion as obtained from the truncator 40, and the default quantization elements in a latter  
10 portion (a portion other than the former portion) from the default QM generator 46 are synthesized. Thus, the synthesized QM generator 44 uses the particular quantization elements in the former portion and the default quantization elements in the latter portion for synthesizing the synthesized quantization elements in matrix.

15 Fig. 3 shows an example of a synthesized quantization elements in matrix in which the former portion F is filled with the particular quantization elements and the latter portion L is filled with the default quantization values.

In the quantizer 34, the DCT coefficients COF in matrix format are quantized by using the synthesized quantization elements in matrix from the  
20 synthesized QM generator 44, and the quantization parameter QP from the QP generator 36. Then, the quantizer 34 generates quantized DCT coefficients COF' in matrix format. The coefficients COF<sub>ij</sub> and COF'<sub>ij</sub> (i and j are positive integers between 1 and 8, inclusive) have the following relationship.

$$COF'_{ij} \propto \frac{COF_{ij}}{QM_{ij} * QP}$$

25 Here, QM<sub>ij</sub> represent quantization elements in matrix as produced from synthesized QM generator 44, QP represent a quantization parameter as

produced from QP generator 36. The quantized DCT coefficients COF' are then further coded in the variable length encoding unit 49, and the compressed video data VD is output from the unit 49 and applied to the decoder shown in Fig. 5.

5            Fig. 5 shows a decoder, according to the present invention, using the quantization matrix for the still and moving pictures. The decoder includes a variable length decoding unit 50, an inverse quantizer 52, an inverse DCT converter 62, an end code detector 56, a synthesized QM generator 54, a default QM generator 58, and a zigzag scan 60.

10           The default QM generator 58 stores a default quantization matrix, such as that shown in Fig. 1A. It is noted that the default quantization matrix stored in the default QM generator 58 is the same one as that stored in the default QM generator 46 shown in Fig. 4. The synthesized QM generator 54 and the zigzag scan 60 are substantially the same as the synthesized QM  
15 generator 44 and the zigzag scan 48, respectively, shown in Fig. 4.

The video data VD transmitted from the encoder of Fig. 4 is applied to the variable length decoding unit 50. Similarly, the quantized parameter QP is applied to inverse quantizer 52, and the simplified data QMt is applied to the end code detector 56.

20           As described above, the simplified data QMt includes particular quantization element in the former portion in the matrix. The particular quantization elements are zigzag scanned by zigzag scan 60 and are stored in the former portion of the synthesized QM generator 54. Then, when the end code is detected by the end code detector 56, the supply of the particular  
25 quantization elements from the end code detector 56 terminates, and in turn, the default quantization elements from the default QM generator 58 zigzag scanned in the latter portion of the synthesized QM generator 54.

Thus, the synthesized quantization matrix generated in the synthesized QM generator 54 in Fig. 5 is the same as the synthesized quantization matrix generated in the synthesized QM generator 44 in Fig. 4. Since the synthesized quantization matrix can be reproduced using the simplified data QMt, it is possible to reproduce the high quality image with less data to be transmitted from encoder to decoder.

Fig. 6 shows one of the ways to code and transmit the truncated quantization matrix.

Here, the unit 1 is the truncated quantization matrix determined in the unit 2 by checking different coding bit rate, different coding picture size, etc..  $x_1, x_2, x_3, \dots$  in unit 1 are those non-zero quantization matrix values used to quantize a block of  $8 \times 8$  DCT coefficients in the same position as  $x_1, x_2, x_3, \dots$ . Other parts of the quantization matrix with zero values in the unit 1 means that the default value of the quantization matrix will be used. In the encoder, same part of DCT coefficients of a  $8 \times 8$  block will be set to zero.

The unit 3 is to scan the non-zero values in the unit 1 into a group of data with larger value being concentrated on the first part of the group. Zig-zag scan is shown here as an example.

The unit 4 shows the optional part to code the scanned data by subtracting neighbouring values to obtain the smaller difference values,  $\Delta x_1, \Delta x_2, \dots$ , as shown in Fig. 6, maybe further followed by huffman coding or other entropy coding methods.

At the same time, the number of non-zero quantization matrix values is also coded and transmitted to decoder, together with those non-zero values. There are different ways to code this information. The simplest method is to code the number by using a fixed 8-bit. Another method is to code the number by using a variable length table which is designed to use less bits to handle the

most frequent cases.

Alternatively, instead of coding and transmitting the number of non-zero quantization matrix values, as shown in Fig. 6, after the last non-zero value,  $x_N$ , or last difference value,  $\Delta x_N$  ( $N=1, 2, 3, \dots$ ) is coded, a specific  
5 symbol is inserted into the bitstream to indicate the termination of the non-zero quantization matrix coding. This specific symbol may be a value which is not used in the non-zero value coding such as zero or a negative value.

Fig. 7 is the truncated quantization matrix with scaling factor  $S$  as weighting for DC only. This scaling factor is adjusted based on the activity of  
10 individual block. The activity information can be obtained by checking the number of AC coefficients left after quantization.  $x_1, x_2, x_3, \dots, x_9$  are the non-zero values in the truncated quantization matrix to be used to quantize  $8 \times 8$  DCT coefficient block, and  $S$  is the weighting for scaling up/down for the first value to adjust the quantizer for DC coefficient.

15 Fig. 8 shows the details about the scaling procedure for the first value in quantization matrix.

The unit 5 quantizes each of  $8 \times 8$  block by applying the truncated quantization matrix first, followed by the required quantization step at that time for that block. The unit 6 checks the number of AC coefficients left after the  
20 above quantization, passing to the unit 7 to decide whether the weighting  $S$  in Fig. 7 is scaled up or down. If more AC coefficients left after the quantization done in the unit 5, then the weighting  $S$  can be scaled up, shown in the unit 8; otherwise scaled down, shown in the unit 9. The unit 10 scales the weighting  $S$  to adjust the first value in the quantization matrix, and the unit 11 re-quantizes  
25 the DC coefficient by using the new adjusted value for block A and output all the DC & AC coefficients to decoder.

The scaling up & down can be chosen some value related to the

present quantization step or a fixed value.

The adjustment of the other quantization matrix values for AC coefficients can be followed the similar way.

A decoder of the adaptive quantization step size scaling and truncated  
5 quantization matrix is shown in Fig. 9.

In the Fig. 9, the decoded bitstream is input to the decoder. The unit  
12 will decode the truncated quantization matrix, and the unit 13 will decode  
the quantization step for each of block. The unit 14 will decode all the DC &  
AC coefficients for each of block. The unit 15 will check the number of AC  
10 coefficients which are not zero, and the scaling factor can be determined in the  
unit 16 by using the information obtained from the unit 15 and following the  
same criteria as in the encoder. All DC & AC coefficients for each of block can  
be inversely quantized in the unit 17 by the decoded scaling quantization  
matrix and the decoded quantization matrix. Finally all the inversely quantized  
15 coefficients are passed to an inverse DCT transform coding unit to reconstruct  
image picture.

The following formula are used for the quantization and inverse  
quantization:

Quantization:

20 For Intra DC:  $\text{Level} = |\text{COF}| // (\text{QM} / 2)$   
For Intra AC:  $\text{Level} = |\text{COF}| * 8 / (\text{QP} * \text{QM})$   
For Inter:  $\text{Level} = (|\text{COF}| - (\text{QP} * \text{QM} / 32)) * 8 / (\text{QP} * \text{QM})$

Inverse Quantization:

For Intra DC:  $|\text{COF}'| = \text{Level} * \text{QM} / 2$   
25 For Others:  $|\text{COF}'| = 0,$   
if  $\text{Level} = 0$   
 $|\text{COF}'| = (2 * \text{LEVEL} + 1) * (\text{QP} * \text{QM} / 16),$



if LEVEL  $\neq$  0, (QP\*QM /16) is odd

$$|\text{COF}'| = (2 * \text{LEVEL} + 1) * (\text{QP} * \text{QM} / 16) - 1,$$

if LEVEL  $\neq$  0, (QP\*QM /16) is even

Where:

5 COF is the transform coefficient to be quantized.

LEVEL is the absolute value of the quantized version of the transform coefficient.

COF' is the reconstructed transform coefficient.

QP is the quantization step size of the current block.

10 QM is the value of the quantization matrix corresponding to the coefficient to be quantized.

Default value of QM is 16.

The presented invention is to make quantization matrix adaptively changed according to coding bit rate, coding size, as well as human visual  
15 system, so that a lot of bits can be saved by truncating and scaling the quantization matrix and encoding the values of the matrix differentially. Therefore it will increase coding efficiency, especially for very low bit rate coding.

The invention being thus described, it will be obvious that the same  
20 may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

## CLAIMS

1. A transform coding method of decoding still and moving pictures from an encoded bitstream employing adaptive quantization step size scaling ,  
5 whereby the decoder comprises the following steps of:  
extracting the binary representation of the quantization step size and quantized coefficients for each block from the said bitstream;  
determining scaling factors based on some criteria derived from the quantization step size and/or the local statistics of the extracted quantized  
10 coefficients;  
obtaining the effective values of the quantization step size for each of the different blocks by combining the decoded quantization step size and the determined scaling factors;  
inverse quantizing the quantized coefficients using the effective  
15 values of the quantization step size;  
transforming the inverse quantized coefficients into blocks of pixels by means of an inverse transform operation; and  
reconstructing the picture from the said blocks of pixels.
- 20 2. A transform coding method of decoding still and moving pictures from an encoded bitstream employing a truncated quantization matrix, whereby the decoder comprises the following steps of:  
extracting the binary coded representation of the value indicating the number of coefficients present in the truncated quantization matrix transmitted  
25 in the encoded bitstream;  
extracting the binary coded representation of the said coefficients of the truncated quantization matrix from the encoded bitstream;

extracting the binary coded representation of the quantization step size and quantized coefficients for each block from the said encoded bitstream;

inverse quantizing the quantized coefficients using the extracted quantization step size and quantization matrix;

5 transforming the inverse quantized coefficients into blocks of pixels by means of an inverse transform operation; and

reconstructing the picture from the said blocks of pixels.

3. A transform coding method of decoding still and moving pictures  
10 from an encoded bitstream employing an adaptive quantization step size scaling and a truncated quantization matrix, whereby the decoder comprises the following steps of:

extracting the binary coded representation of the value indicating the number of coefficients present in the truncated quantization matrix transmitted  
15 in the encoded bitstream;

extracting the binary coded representation of the said coefficients of the truncated quantization matrix from the encoded bitstream;

extracting the binary coded representation of the quantization step size and quantized coefficients for each block from the said encoded bitstream;

20 determine scaling factors based on some criteria derived from the quantization step size and/or the local statistics of the extracted quantized coefficients;

obtaining the effective values of the truncated quantization matrix for each of the different blocks by combining the entropy decoded matrix values  
25 and the determined scaling factors;

inverse quantizing the quantized coefficients using the quantization step size and quantization matrix;

transforming the inverse quantized coefficients into block of pixels  
by means of an inverse transform operation; and  
reconstructing the picture from the said blocks of pixels.

- 5 4. A transform coding method of decoding still and moving pictures  
from an encoded bitstream employing a truncated quantization matrix,  
whereby the decoder comprises the following steps of:

extracting a plurality of the binary coded representation of the  
coefficients of the truncated quantization matrix from the encoded bitstream  
10 until a unique terminating symbol is encountered in the encoded bitstream;  
extracting the binary coded representation of the quantization step  
size and quantized coefficients for each block from the said encoded bitstream;  
inverse quantizing the quantized coefficients using the extracted  
quantization step size and quantization matrix;  
15 transforming the inverse quantized coefficients into blocks of pixels  
by means of an inverse transform operation; and  
reconstructing the picture from the said blocks of pixels.

5. A transform coding method of decoding still and moving pictures  
20 from an encoded bitstream employing an adaptive quantization step size  
scaling and a truncated quantization matrix, whereby the decoder comprises  
the following steps of:

extracting a plurality of the binary coded representation of the  
coefficients of the truncated quantization matrix from the encoded bitstream  
25 until a unique terminating symbol is encountered in the encoded bitstream;  
extracting the binary coded representation of the quantization step  
size and quantized coefficients for each block from the said encoded bitstream;

determine scaling factors based on some criteria derived from the quantization step size and/or the local statistics of the extracted quantized coefficients;

obtaining the effective values of the truncated quantization matrix for  
5 each of the different blocks by combining the entropy decoded matrix values and the determined scaling factors;

inverse quantizing the quantized coefficients using the quantization step size and quantization matrix;

transforming the inverse quantized coefficients into block of pixels  
10 by means of an inverse transform operation; and

reconstructing the picture from the said blocks of pixels.

6. A method of decoding still and moving pictures from an encoded bitstream employing truncated quantization matrix as in claims 2, 3, 4 and 5,  
15 where extracting the binary coded representation of the said coefficients of the truncated quantization matrix from the encoded bitstream, further comprises the steps of

obtaining the said differential values for the truncated quantization matrix;

20 inverse differential coding the above obtained difference values to construct the original values of the said truncated quantization matrix in one dimension;

inverse zig-zag scanning or other scanning the one dimensional constructed values above to form the said truncated quantization matrix; and

25 completing the truncated quantization matrix by appending the corresponding coefficients of the default quantization matrix in place of the coefficients that were not transmitted in the truncated quantization matrix.

7. A transform coding method of encoding still and moving pictures into an encoded bitstream employing an adaptive quantization step size scaling, whereby the encoder comprises the following steps of:

5        sampling an input image into a plurality of blocks comprising of two dimensional array of pixels;

         converting the said sampled blocks of pixels into transform domain;

         quantizing the said block of transformed coefficients by applying the selected quantization step size to the said block of transformed coefficients;

10       determine scaling factors based on some criteria derived from the quantization step size and/or the local statistics of the extracted quantized coefficients;

         obtaining the effective values of the quantization step size for each of the different blocks by combining the quantization step size and the determined

15       scaling factors;

         re-quantizing the coefficients in the said transformed coefficients using the effective values of the quantization step size;

         encoding the said final quantized transformed coefficients and sending the coded information to decoder.

20

8. A transform coding method of encoding still and moving pictures into an encoded bitstream employing a truncated quantization matrix, whereby the encoder comprises the following steps of:

25       sampling an input image into a plurality of blocks comprising of two dimensional array of pixels;

         converting the said sampled blocks of pixels into transform domain;

finding a general and complete quantization matrix for the image according to human visual system;

truncating the said complete quantization matrix according to some decision criteria;

5 quantizing the said block of transformed coefficients by applying the said truncated quantization matrix and the selected quantization step size to the said block of transformed coefficients;

encoding the binary coded representation of the value indicating the number of coefficients present in the truncated quantization matrix transmitted  
10 in the encoded bitstream;

encoding the binary coded representation of the said coefficients of the truncated quantization matrix into the encoded bitstream; and

encoding the binary coded representation of the said quantization step size and quantized transformed coefficients of each of the blocks into the  
15 encoded bitstream.

9. A transform coding method of encoding still and moving pictures into an encoded bitstream employing an adaptive quantization step size scaling and a truncated quantization matrix, whereby the encoder comprises the following  
20 steps of:

sampling an input image into a plurality of blocks comprising of two dimensional array of pixels;

converting the said sampled blocks of pixels into transform domain;

finding a general and complete quantization matrix for the image  
25 according to human visual system;

truncating the said complete quantization matrix according to some decision criteria;

quantizing the said block of transformed coefficients by applying the said truncated quantization matrix and the selected quantization step size to the said block of transformed coefficients;

5       determine scaling factors based on some criteria derived from the quantization step size and/or the local statistics of the extracted quantized coefficients;

obtaining the effective values of the truncated quantization matrix for each of the different blocks by combining the initial truncated quantization matrix values and the determined scaling factors;

10       re-quantizing the coefficients in the said transformed coefficients using the effective values of the truncated quantization matrix;

encoding the binary coded representation of the value indicating the number of coefficients present in the truncated quantization matrix transmitted in the encoded bitstream;

15       encoding the binary coded representation of the said coefficients of the truncated quantization matrix into the encoded bitstream; and

encoding the binary coded representation of the said quantization step size and the said final quantized transformed coefficients of each of the blocks into the encoded bitstream.

20

10.       A transform coding method of encoding still and moving pictures into an encoded bitstream employing a truncated quantization matrix, whereby the encoder comprises the following steps of:

25       sampling an input image into a plurality of blocks comprising of two dimensional array of pixels;

converting the said sampled blocks of pixels into transform domain;



finding a general and complete quantization matrix for the image according to human visual system;

truncating the said complete quantization matrix according to some decision criteria;

5 quantizing the said block of transformed coefficients by applying the said truncated quantization matrix and the selected quantization step size to the said block of transformed coefficients;

encoding the plurality of the binary coded representation of the said coefficients of the truncated quantization matrix into the encoded bitstream;

10 encoding a specific unique symbol indicating the end of the truncated quantization matrix into the encoded bitstream, and

encoding the binary coded representation of the said quantization step size and quantized transformed coefficients of each of the blocks into the encoded bitstream.

15

11. A transform coding method of encoding still and moving pictures into an encoded bitstream employing an adaptive quantization step size scaling and a truncated quantization matrix, whereby the encoder comprises the following steps of:

20 sampling an input image into a plurality of blocks comprising of two dimensional array of pixels;

converting the said sampled blocks of pixels into transform domain;

finding a general and complete quantization matrix for the image according to human visual system;

25 truncating the said complete quantization matrix according to some decision criteria;

quantizing the said block of transformed coefficients by applying the said truncated quantization matrix and the selected quantization step size to the said block of transformed coefficients;

5       determine scaling factors based on some criteria derived from the quantization step size and/or the local statistics of the extracted quantized coefficients;

obtaining the effective values of the truncated quantization matrix for each of the different blocks by combining the initial truncated quantization matrix values and the determined scaling factors;

10       re-quantizing the coefficients in the said transformed coefficients using the effective values of the truncated quantization matrix;

encoding the binary coded representation of the said coefficients of the truncated quantization matrix into the encoded bitstream;

15       encoding a specific unique symbol indicating the end of the truncated quantization matrix into the encoded bitstream, and

encoding the binary coded representation of the said quantization step size and the said final quantized transformed coefficients of each of the blocks into the encoded bitstream.

20   12.     A method of encoding still and moving pictures into an encoded bitstream employing truncated quantization matrix as in claims 8, 9 10 and 11, where encoding the said binary coded representation of the coefficients of the truncated quantization matrix into the encoded bitstream, further comprises the steps of

25       zig-zag scanning or other scanning the said truncated quantization matrix above to form a one dimensional array of values; and

subtracting the previous value from the current value for each of the above the original values of the said truncated quantization matrix in the order of the one dimension scan to obtain differential values;

entropy coding the said differential values for the truncated  
5 quantization matrix for encoding into the bitstream, by means of entropy coding.

13. A method of adaptively truncating the quantization matrix in transform coding according to claims 8, 9, 10 and 11, whereby the said  
10 truncating criteria comprises the step of determining the truncating pattern based on the scanning order to obtain the minimum number of coefficients that are need to be changed while leaving the rest of the coefficients as the default values, and selecting only the coefficients that have changed as part of the truncated quantization matrix to be encoded in the bitstream.

15

14. A method of adaptively scaling the quantization step size in transform coding according to claims 1 and 7, whereby determining the scale factor and scaling the values of the said quantization step size further comprises the following steps of:

20 checking the number of non-zero AC coefficients of the said block of quantized transformed coefficients;

increasing the scale factor for the blocks with more non-zero AC coefficients while decreasing the scale factor for the blocks with less non-zero AC coefficients;

25 applying the scale factor to the first coefficient and any predetermined number of coefficients of the block; and

employing the same criteria in the encoder as well as in the decoder.

15. A method of adaptively scaling the quantization matrix in transform coding according to claims 3, 5, 9 and 11, whereby determining the scale factor and scaling the values of the said truncated quantization matrix further  
5 comprises the following steps of:

checking the number of non-zero AC coefficients of the said block of quantized transformed coefficients;

increasing the scale factor for the blocks with more non-zero AC coefficients while decreasing the scale factor for the blocks with less non-zero  
10 AC coefficients;

applying the scale factor to the first coefficient and any predetermined number of coefficients of the said truncated quantization matrix; and

employing the same criteria in the encoder as well as in the decoder.

15 16. A method of adaptively scaling the quantization step size in transform coding according to claims 1 and 7, whereby determining the scale factor and scaling the values of the said quantization step size further comprises the following steps of:

checking the number of non-zero AC coefficients of the said block of  
20 quantized transformed coefficients;

applying a predetermine quantization step size to the DC coefficient for blocks with AC coefficients while applying a second alternative quantization step size to the DC coefficient for the blocks with no AC coefficients;

25 employing the same criteria in the encoder as well as in the decoder.

17. A method of decoding of quantization matrix in transform coding according to claims 2 and 3, whereby extracting the binary coded representation of the value indicating the number of coefficients present in the truncated quantization matrix and the coefficients of the truncated quantization  
5 matrix, comprises the following steps of:

decoding the said number of coefficients presents in the truncated quantization matrix by using a fixed or variable length code in the bitstream; followed by

decoding the coefficients of the truncated quantization matrix by a  
10 series of fixed or variable length code in the bitstream, the number of which is determined by the said number of coefficients present in the truncated quantization matrix.

18. A method of decoding of quantization matrix in transform coding  
15 according to claims 4 and 5, whereby extracting a plurality of the binary coded representation of the coefficients of the truncated quantization matrix from the encoded bitstream comprises the step of:

decoding the plurality of coefficients of the truncated quantization matrix by a series of fixed or variable length code in the bitstream and  
20 terminating only when a specific unique terminating symbol is encountered.

19. A method of encoding of quantization matrix in transform coding according to claims 8 and 9, whereby encoding the binary coded representation of the value indicating the number of coefficients present in the truncated  
25 quantization matrix and the coefficients of the truncated quantization matrix, comprises the following steps of:

encoding the said number of coefficients presents in the truncated quantization matrix by using a fixed or variable length code in the bitstream; followed by

5 encoding the coefficients of the truncated quantization matrix by a series of fixed or variable length code in the bitstream, the number of which is determined by the said number of coefficients presents in the truncated quantization matrix.

20. A method of encoding of quantization matrix in transform coding  
10 according to claims 10 and 11, whereby encoding the binary coded representation of the said coefficients of the truncated quantization matrix into the encoded bitstream, comprises the following step of:

encoding the coefficients of the truncated quantization matrix by a series of fixed or variable length code in the bitstream, and inserting a specific  
15 unique symbol to indicate the end of the truncated quantization matrix.

21. An encoding and decoding method according to claims 1, 3, 7 and 9, where a different scaling factor is derived for each of the coefficients in the block.

20

22. An encoding and decoding method employing truncated quantization matrix according to claims 2, 3, 4, 5, 8, 9, 10 and 11, where a separate quantization matrix is used for the luminance and chrominance component of the picture.

25

23. An encoding method for encoding a quantization matrix for still and moving picture comprising:

holding a default quantization matrix including a plurality of quantization elements having predetermined values;

generating a particular quantization matrix including a plurality of quantization elements having selected values;

5 reading said particular quantization matrix in a predetermined zigzag pattern;

terminating the reading of the particular quantization matrix at a selected position while reading in the predetermined zigzag pattern, and producing a former portion of the particular quantization matrix;

10 adding an end code after the quantization elements of said former portion of the particular quantization matrix;

reading said default quantization matrix in said predetermined zigzag pattern from a position immediately after said selected position, and producing a latter portion of the default quantization matrix; and

15 synthesizing said former portion of the particular quantization matrix and said latter portion of the default quantization matrix to form a synthesized quantization matrix.

24. A decoding method for decoding a quantization matrix for still and  
20 moving picture comprising:

holding a default quantization matrix including a plurality of quantization elements having predetermined values;

receiving a number of quantization elements and an end code;

25 positioning said received quantization elements in a predetermined zigzag pattern to form a former portion, and terminating the positioning of the received quantization elements upon detection of said end code;

reading said default quantization matrix in said predetermined zigzag pattern from a position immediately after said former portion, and forming a latter portion with quantization elements from the default quantization matrix; and

5 synthesizing said former portion of the particular quantization matrix and said latter portion of the default quantization matrix to form a synthesized quantization matrix.

25. An encoder for encoding a quantization matrix for still and moving  
10 picture comprising:

a holding member which holds a default quantization matrix including a plurality of quantization elements having predetermined values;

a generating member which generates a particular quantization matrix including a plurality of quantization elements having selected values;

15 a reading member which reads said particular quantization matrix in a predetermined zigzag pattern;

a terminating member which terminates the reading of the particular quantization matrix at a selected position while reading in the predetermined zigzag pattern, and producing a former portion of the particular quantization  
20 matrix;

an adding member which adds an end code after the quantization elements of said former portion of the particular quantization matrix;

a reading member which reads said default quantization matrix in said predetermined zigzag pattern from a position immediately after said selected  
25 position, and producing a latter portion of the default quantization matrix; and



a synthesizing member which synthesizes said former portion of the particular quantization matrix and said latter portion of the default quantization matrix to form a synthesized quantization matrix.

- 5 26. A decoder for decoding a quantization matrix for still and moving picture comprising:

a holding member which holds a default quantization matrix including a plurality of quantization elements having predetermined values;

- 10 a receiving member which receives a number of quantization elements and an end code;

a positioning member which positions said received quantization elements in a predetermined zigzag pattern to form a former portion, and terminating the positioning of the received quantization elements upon detection of said end code;

- 15 a reading member which reads said default quantization matrix in said predetermined zigzag pattern from a position immediately after said former portion, and forming a latter portion with quantization elements from the default quantization matrix; and

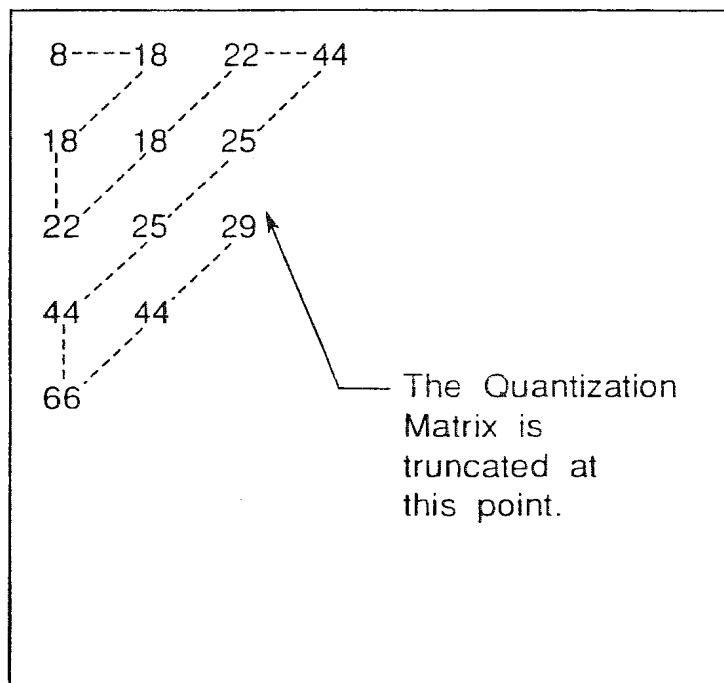
- 20 a synthesizing member which synthesizes said former portion of the particular quantization matrix and said latter portion of the default quantization matrix to form a synthesized quantization matrix.

*Fig.1A*

8	16	19	22	26	27	29	34
16	16	22	24	27	29	34	37
19	22	26	27	29	34	34	38
22	22	26	27	29	34	37	40
22	26	27	29	32	35	40	48
26	27	29	32	35	40	48	58
26	27	29	34	38	46	56	69
27	29	35	38	46	56	69	83

*Fig.1B*

8	18	22	44	78	200	200	200
18	18	25	48	71	200	200	200
22	25	29	54	87	200	200	200
44	44	52	54	87	200	200	200
66	78	81	87	96	200	200	200
200	200	200	200	200	200	200	200
200	200	200	200	200	200	200	200
200	200	200	200	200	200	200	200

*Fig.2A**Fig.2B*

8	18	22	44	78	78	87	108
18	18	25	48	71	87	96	118
22	25	29	54	87	96	108	123
44	44	52	54	87	96	108	132
66	78	81	87	96	108	115	140
78	78	87	96	108	115	123	158
87	87	96	108	115	123	132	167
96	108	118	123	132	140	158	200

*Fig.3*

The diagram shows an 8x8 grid of numbers enclosed in a dashed rectangular border. A dashed line runs diagonally from the top-left to the bottom-right, passing through the center of the grid. A wavy line labeled 'F' is on the left side of the grid, and a wavy line labeled 'L' is on the right side. The numbers in the grid are as follows:

8	18	22	24	26	27	29	34
18	18	25	24	27	29	34	37
22	25	29	27	29	34	34	38
44	44	26	27	29	34	37	40
66	26	27	29	32	35	40	48
26	27	29	32	35	40	48	58
26	27	29	34	38	46	56	69
27	29	35	38	46	56	69	83

*Fig.4*

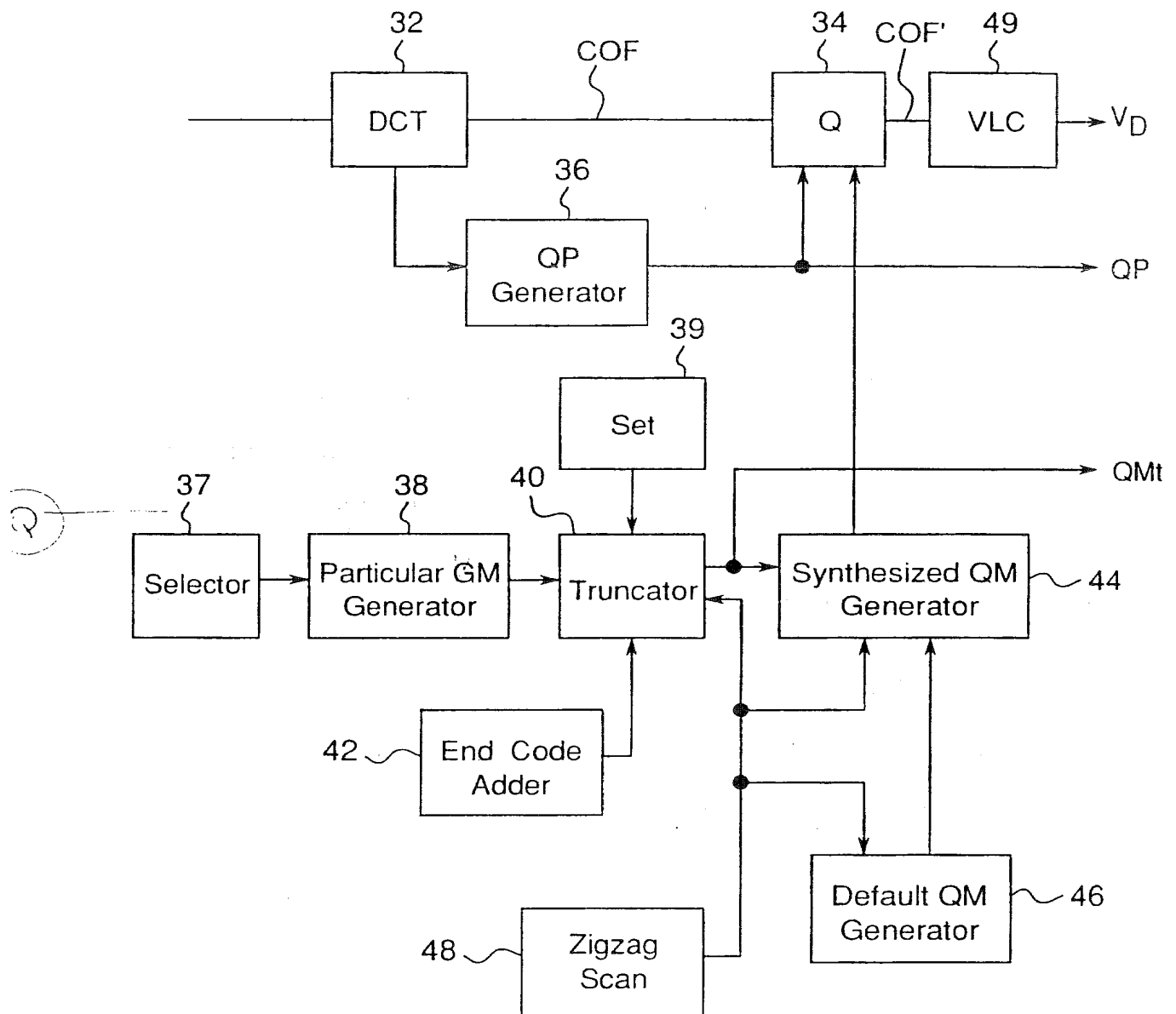
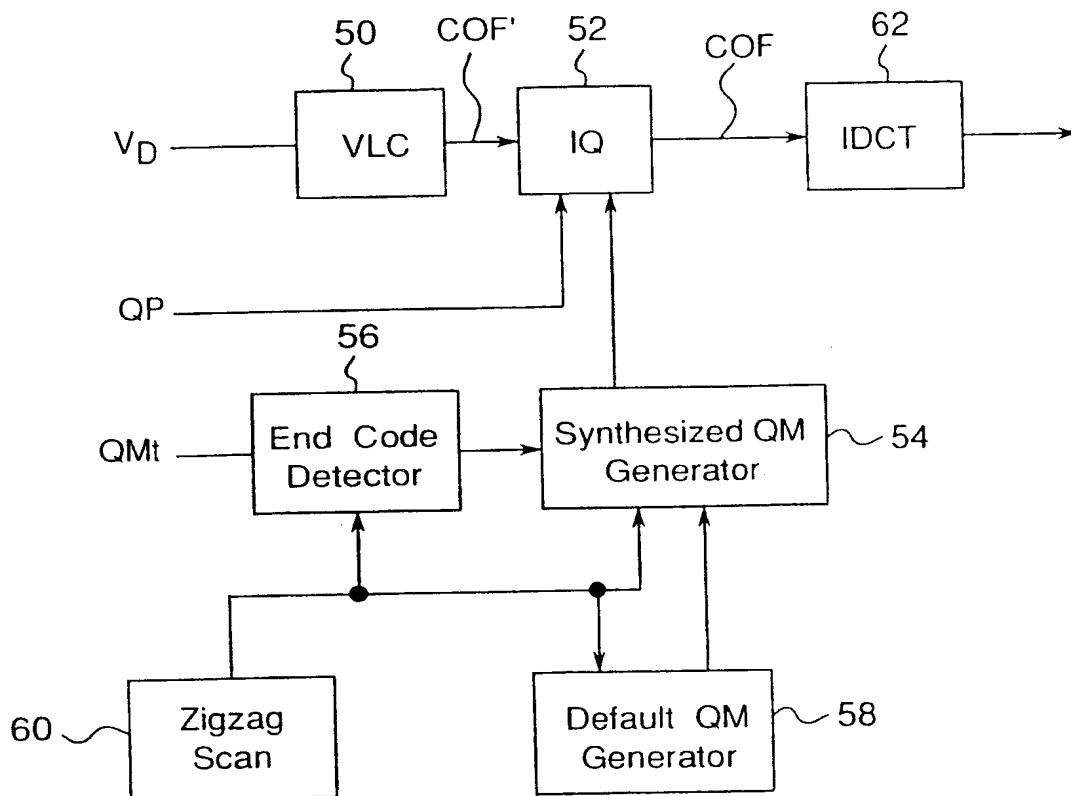
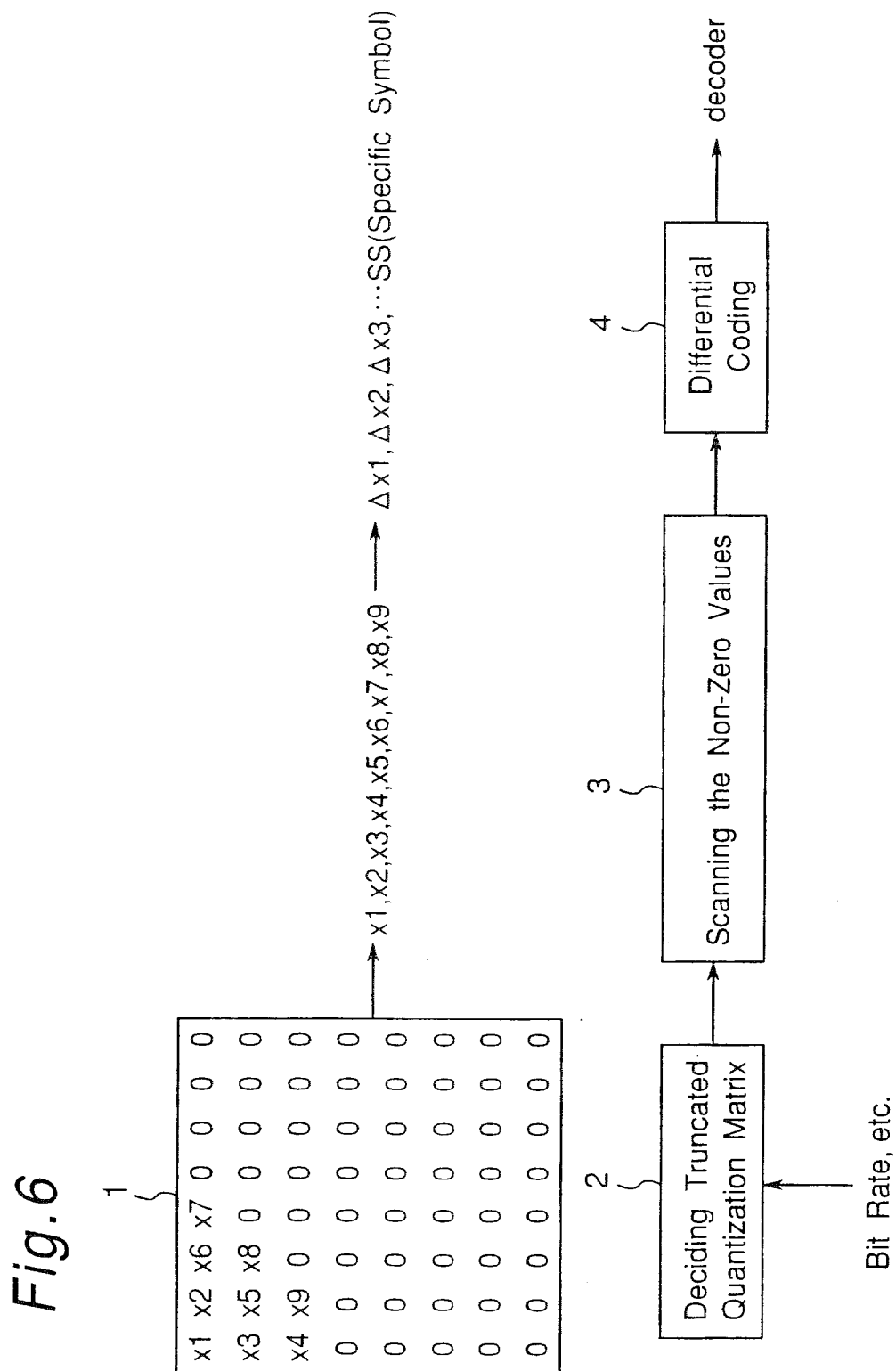


Fig.5





*Fig.7*

S*x1	x2	x6	x7	0	0	0	0
x3	x5	x8	0	0	0	0	0
x4	x9	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0



Fig.8

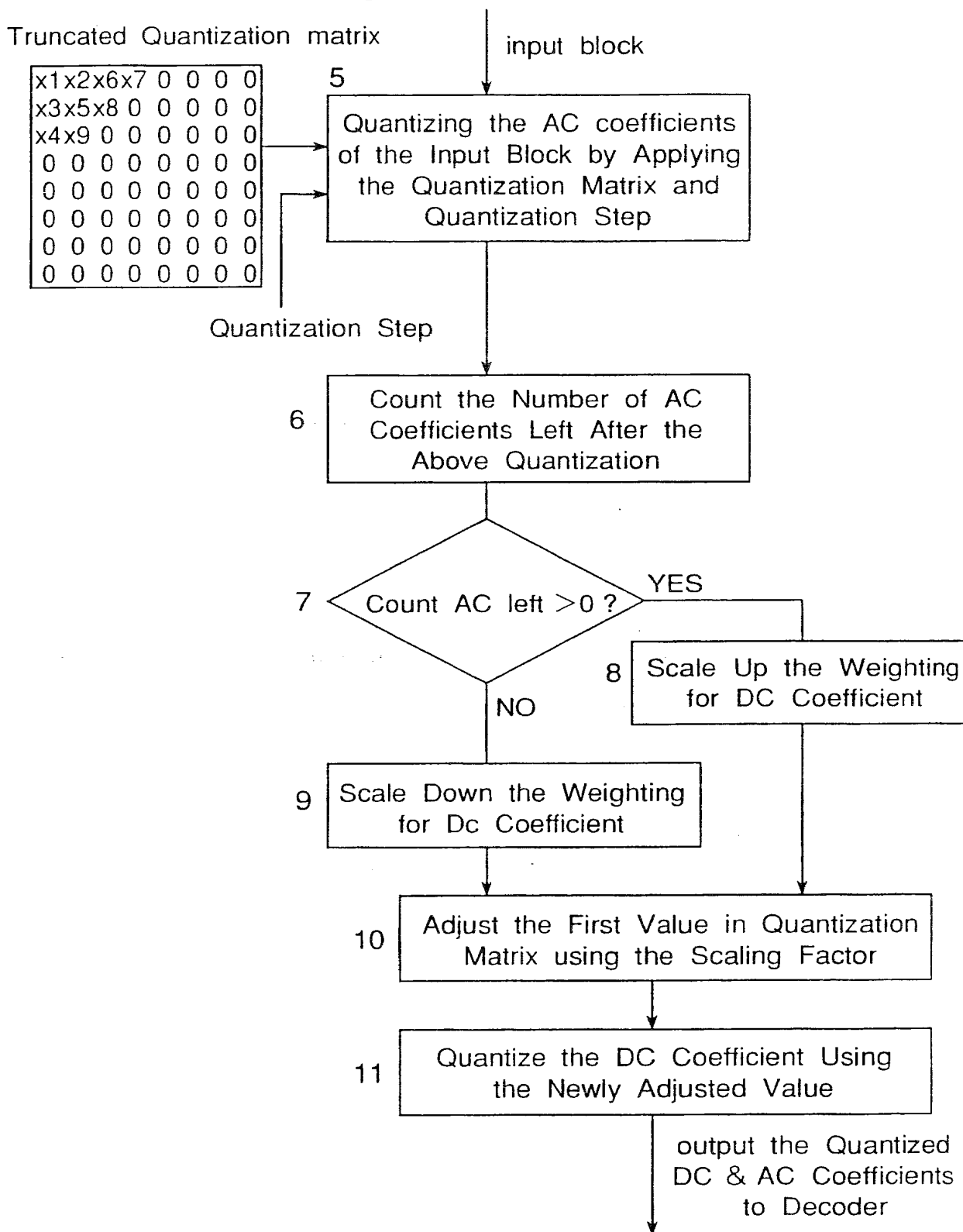
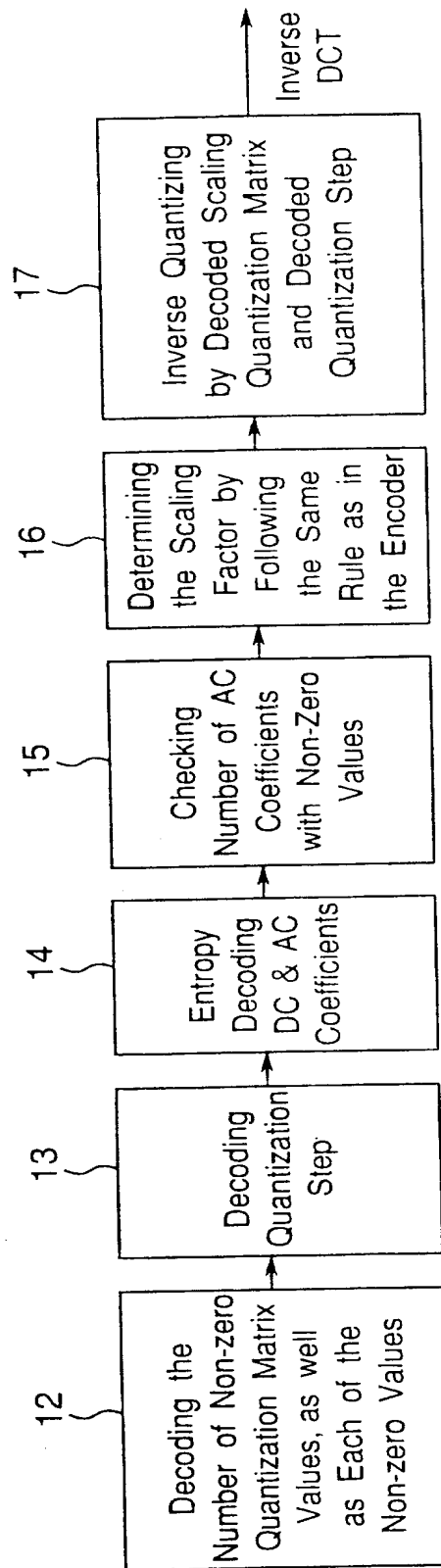


Fig. 9



## INTERNATIONAL SEARCH REPORT

International Application No

PCT/JP 98/00474

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 H04N7/30 G06T9/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 H04N G06T

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 539 468 A (SUZUKI KAZUHIRO ET AL) 23 July 1996 see abstract see column 4, line 10 - line 53; figures 8,10 see column 8, line 59 - column 9, line 39 ---	1-26
A	US 5 535 138 A (KEITH MICHAEL) 9 July 1996 see abstract see column 1, line 60 - column 2, line 8 see column 26, line 37 - line 41 ---	1-26
A	EP 0 740 472 A (FUJITSU LTD) 30 October 1996 see the whole document ---	1-26
-/--		

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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Gries, T

## INTERNATIONAL SEARCH REPORT

International Application No

PC1/JP 98/00474

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A	US 5 335 016 A (NAKAGAWA CHIHIRO) 2 August 1994 see the whole document ---	1-26
A	US 5 500 678 A (PURI ATUL) 19 March 1996 see abstract; figures 7,8 see column 4, line 26 - column 5, line 27 ---	1-26
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